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# **REPORT No. 308**

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## **AIRCRAFT ACCIDENTS**

### **METHOD OF ANALYSIS**

**Report Prepared by  
Special Committee on the Nomenclature,  
Subdivision, and Classification of Aircraft Accidents**

AUGUST 15, 1928.

THE EXECUTIVE COMMITTEE,

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS,

*Washington, D. C.*

GENTLEMEN: There is submitted herewith the report of the special committee on the nomenclature, subdivision, and classification of aircraft accidents organized in pursuance of resolution adopted by the executive committee on March 1, 1928. Attention is invited to the committee's recommendations at the end of its report.

Respectfully,

SPECIAL COMMITTEE ON THE NOMENCLATURE, SUBDIVISION,  
AND CLASSIFICATION OF AIRCRAFT ACCIDENTS  
GEORGE K. BURGESS, *Chairman*.

# AIRCRAFT ACCIDENTS

## METHOD OF ANALYSIS

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# REPORT No. 308

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### INTRODUCTION

#### PURPOSE AND ORGANIZATION

This report on a method of analysis of aircraft accidents has been prepared by a special committee on the nomenclature, subdivision, and classification of aircraft accidents organized by the National Advisory Committee for Aeronautics in response to a request dated February 18, 1928, from the air coordination committee consisting of the Assistant Secretaries for Aeronautics in the Departments of War, Navy, and Commerce. The work was undertaken in recognition of the difficulty of drawing correct conclusions from efforts to analyze and compare reports of aircraft accidents prepared by different organizations using different classifications and definitions. The air coordination committee's request was made "in order that practices used may henceforth conform to a standard and be universally comparable." The purpose of the special committee therefore was to prepare a basis for the classification and comparison of aircraft accidents, both civil and military.

The special committee was organized in pursuance of resolution adopted by the executive committee of the National Advisory Committee for Aeronautics on March 1, 1928, and held its initial meeting on March 19, 1928. Sixteen meetings were held, the last being on July 17, 1928.

Following is the organization of the committee:

*Representatives of the National Advisory Committee for Aeronautics:*

Dr. George K. Burgess, chairman.

Mr. George W. Lewis.

*Representatives of the Army Air Corps:*

Lieut. D. B. Phillips, United States Army.

Lieut. J. D. Barker, United States Army.

*Representatives of the Bureau of Aeronautics of the Navy:*

Lieut. Commander L. C. Stevens, Construction Corps, United States Navy.

Lieut. Charles R. Brown, United States Navy.

*Representatives of the Aeronautics Branch of the Department of Commerce:*

Mr. Daniel deR. Scarritt (succeeded by Mr. Edward P. Howard).

Mr. Lester T. Bradbury.

Mr. Scarritt, having resigned from the Government service, was succeeded by Mr. Howard as a representative of the Department of Commerce at the ninth meeting of the committee. Most of the meetings were attended also by Mr. E. M. Kintz, of the Department of Commerce, and Mr. Starr Truscott, of the National Advisory Committee for Aeronautics, and they assisted the committee in the preparation of this report. In connection with the preparation of the definitions and explanations involving the physiological aspects of aviation Dr. L. H. Bauer, of the Department of Commerce, and Lieut. Commander John R. Poppen, Medical Corps, United States Navy, were also of assistance.

## FOREIGN COOPERATION

The meeting of May 22, 1928, was attended by the following representatives of foreign governments:

Commander Silvio Scaroni, air attaché, Italian Embassy.

Wing Commander T. G. Hetherington, air attaché, British Embassy.

Maj. Georges Thenault, assistant military attaché for aeronautics, French Embassy.

Lieut. Yoshitake Miwa, Imperial Japanese Navy, assistant naval attaché, Japanese Embassy.

At that meeting the proposed method of analyzing aircraft accidents was explained and the value of a uniform system for reporting accidents was discussed. It was suggested that the representatives of the foreign governments consult with the personnel in their governments who were responsible for analyzing and reporting aircraft accidents, regarding the possibility of adopting the proposed method and form.

Great interest was expressed, and it was the opinion of those present that the adoption of a uniform system would be advantageous. The representatives of the foreign governments were invited to submit comments and suggestions regarding changes, but none had been received up to the date of the last meeting of the committee. This was probably due to the necessarily lengthy period of time required for translation, consideration, and approval.

## GENERAL CONSIDERATIONS

## DEFINITION OF AN AIRCRAFT ACCIDENT

An aircraft accident is an occurrence which takes place while an aircraft is being operated as such and as a result of which a person or persons are injured or killed, or the aircraft receives appreciable or marked damage through the forces of external contact or through fire. A collision of two or more aircraft should be analyzed and reported statistically as one accident.

## IMMEDIATE CAUSES

In the course of its meetings the committee considered various methods of analyzing aircraft accidents. These included studies and classification by (a) the immediate causes, (b) the underlying causes, (c) the nature, and (d) the results of the accidents. Each of these methods was considered in detail, and it was finally found possible to reduce their analysis to the methods described in this report and combine the results in the form of a single chart.

A plan devised by Lieutenant Philips, of the Army, and Lieutenant Brown, of the Navy, for the division of the immediate causes of aircraft accidents into four major classes, and providing for the further subdivision of these major classes as seemed desirable, together with proposed definitions of these classes and subdivisions, was submitted to the committee for consideration.

The outline and definitions of the classification of accidents as presented to the committee were carefully considered by the members at a number of meetings, and modifications were made in the plan as originally drafted so as to provide for every type of aircraft accident in the light of the experience of the members in classifying and analyzing accidents in the Government services.

In working out this outline the committee attempted to provide a plan which would permit of the careful analysis of aircraft accidents by the different organizations from the point of view of both personnel and matériel problems. The plan also permits of the analysis of a given accident into two or more distinct causes and makes possible, by the use of percentages, the indication of the relative weight of each cause in any particular accident.

## CROSS ANALYSIS

The plan provides for the analysis of crashes according to the nature of the accident (take-off accidents, tail spins following engine failure, etc.), the degree of seriousness of personnel injuries, and the amount of damage occurring to matériel.

Furthermore, the system, through the use of a cross-analysis method, allows for analyzing pilot errors and matériel failures according to the underlying causes of these errors or failures.

The plan also provides for the analysis of aircraft accidents of different organizations on the same basis, so that the records will be comparable and the preparation of a composite report of all aircraft accidents will be possible. It is the belief of the committee that if all aircraft accidents occurring in all agencies are classified in the manner recommended a composite of all the accidents will offer a basis upon which a study may be made and correct conclusions drawn.

#### AIRCRAFT ACCIDENT ANALYSIS FORM

In drawing up the aircraft accident analysis form and the accompanying definitions the committee had in mind the frequency rate of accidents from the various causes, the logical lines along which studies should be conducted, and the ease with which these studies can be made from this chart. It is recognized that to make a detailed study of accidents due to any one cause a further subdivision may be necessary. However, if all accidents are classified according to this chart the major causes can be easily determined and further investigation can be readily carried out for the purpose of eliminating these causes.

It was also recognized, in working out this chart, that the division of immediate causes between personnel and matériel as set forth in the chart and definitions was more or less arbitrary, since all defects of aircraft can in the last analysis be attributed to errors of personnel, whether in operation, inspection, maintenance, manufacture, or design. Since the purposes of the accident study seemed to be best served by drawing attention to defects of matériel, even though traceable ultimately to personnel errors, the line between personnel and matériel in the immediate causes was drawn at the operating personnel of the aircraft. In other words, under the main heading "Personnel" there are included only those accidents for which personnel engaged in operating the aircraft are responsible. Accidents due to matériel failure are classified under "Matériel" even though personnel charged with design, construction, or operation may be held responsible for the failure. Errors due to personnel other than those immediately accessory to the operation of the aircraft are shown in the "Underlying causes" or "Cross analysis," as set forth hereinafter, rather than in the main headings of immediate causes.

The plan as drawn up by the committee is not in any sense final or complete, but is presented to provide a working basis for the study of aircraft accidents from all sources.

#### WEIGHTING OF ACCIDENTS

Where two or more factors cause an accident, part will be charged to each; for example, in the case of an avoidable accident following an engine failure the responsibility for the accident might be considered to be equally divided between the pilot and the power plant, in which case 50 per cent would be charged to "Personnel" and 50 per cent to "Matériel." If the responsibility for the accident rested largely upon the pilot, "Personnel" would be charged with 60, 70, or 80 per cent of the accident, or even more, depending upon the degree of responsibility decided upon. Conversely in the above cases "Matériel" and "Miscellaneous" would be charged with a total of 40, 30, or 20 per cent of the accident. This same division of responsibility might be carried out under "Personnel" or other subheads. However, in the particular case cited "Errors of pilot" would be the only division of "Personnel" which could be charged with this accident. If 80 per cent of the accident were charged to "Personnel" in the above instance, then 80 per cent of the accident would be charged to "Errors of pilot." Then, assuming that the responsibility for such piloting error rested jointly upon error of judgment and poor technique, a still further subdivision would be made and 40 per cent of an accident would be charged to "Error of judgment" and 40 per cent to "Poor technique." Thus the factors of each crash could be traced down to the last subdivision under any heading and weighted in accordance with their importance.

N.A.C.A. AIRCRAFT ACCIDENT ANALYSIS FORM																					
CLASSIFICATION OF ACCIDENT NATURE: .....				UNDERLYING CAUSES OF ACCIDENT:																	
				ERRORS OF PILOT								MATERIEL FAILURES									
				LACK OF EXPERIENCE		PHYSICAL AND PSYCHOLOGICAL		FAULTY INSTRUCTIONS		INSPECTION		MATERIALS		DESIGN		INDETERMINATE					
				GENERAL	SPECIAL	DISEASE OR DEFECT	POOR REACTION	OPERATING	MAINTENANCE	MANUFACTURING	OVERHAUL	MAINTENANCE	INDETERMINATE	ORIGINALLY DEFECTIVE	DETERIORATED			INDETERMINATE	STRENGTH (STRUCTURAL)	ARRANGEMENT	AERODYNAMIC
IMMEDIATE CAUSES OF ACCIDENT				TOTAL	RECENT	RECENT	RECENT	INHERENT	TEMPORARY	INHERENT	TEMPORARY										
%		%		%																	
PERSONNEL	ERRORS OF PILOT	ERROR OF JUDGMENT																			
		POOR TECHNIQUE																			
		DISOBEDIENCE OF ORDERS																			
		CARELESSNESS OR NEGLIGENCE																			
		MISCELLANEOUS																			
		ERRORS OF SUPERVISORY PERSONNEL																			
	ERRORS OF OTHER PERSONNEL																				
MATERIEL	POWER PLANT FAILURE	FUEL SYSTEM																			
		COOLING SYSTEM																			
		IGNITION SYSTEM																			
		LUBRICATION SYSTEM																			
		ENGINE STRUCTURE																			
		PROPELLER AND PROPELLER ACCESSORIES																			
		ENGINE CONTROL SYSTEM																			
		MISCELLANEOUS																			
		UNDETERMINED																			
	STRUCTURAL FAILURE	FLIGHT CONTROL SYSTEM																			
		MOVABLE SURFACES																			
		STABILIZING SURFACES																			
		WINGS, STRUTS, AND BRACINGS																			
		LANDING GEAR																			
		WHEELS, TIRES AND BRAKES																			
		SEAPLANE FLOAT OR BOAT																			
		FUSELAGE, ENGINE MOUNT AND FITTINGS																			
		TAIL SKID OR WHEEL ASSEMBLY																			
		ARRESTING APPLIANCES ON AIRCRAFT																			
		MISCELLANEOUS																			
			UNDETERMINED																		
		HANDLING QUALITIES																			
		INSTRUMENTS																			
		LAUNCHING DEVICES																			
	ARRESTING DEVICES																				
MISCELLANEOUS	WEATHER																				
	DARKNESS																				
	AIRPORT OR TERRAIN																				
	OTHER																				
UNDETERMINED AND DOUBTFUL																					

PREPARED AND RECOMMENDED BY  
 SPECIAL COMMITTEE ON THE NOMENCLATURE, SUBDIVISION  
 AND CLASSIFICATION OF AIRCRAFT ACCIDENTS  
 NATIONAL ADVISORY COMMITTEE  
 FOR AERONAUTICS  
 JULY 17, 1928

FORM-A



## CLASSIFICATION OF ACCIDENTS

For the purpose of comparative study aircraft accidents may be divided into groups of accidents of the same general characteristics. Accident prevention must be regarded as the primary purpose of aircraft study. Studies of accident causes point out needed remedies more clearly when they are supplemented by certain studies based upon the nature and results of the accident.

For example, in both bad landings and tail spins the principal cause is usually errors of the pilot. Statistics based upon the study of causes merely show that pilots' errors are responsible for more than half of all accidents and the formulation of remedies for the situation appears difficult. If, however, the same accidents are classified according to their nature and results, it is found that the tail spin is the kind of accident that is by far the most prevalent among those which produce fatal consequences. It is apparent that new designs which decrease the tendency of airplanes to spin, or new training methods which increase the ability of pilots to avoid falling into spins and to recover from them quickly, will have a marked influence toward the prevention of fatal accidents.

Likewise, the study based upon nature and results indicates, in the case of collisions, that this kind of accident is third in importance among those which produce fatal results, and that these accidents are much more prevalent during winter months than in summer; and while remedies are not so obvious as in the case of tail spins some lines of attack immediately suggest themselves.

The following classifications for study of accidents according to their nature are recommended:

## I. NATURE OF THE ACCIDENT

This consists of dividing accidents into separate classes according to the type of accident which occurs.

1. *Class A—Collisions in full flight with other aircraft.*—This includes all collisions with airplanes, balloons, or other aircraft while the colliding aircraft is at flying speed or at an altitude which permits free maneuvering. It excludes collisions (1) on the ground while taxiing, taking off, or landing, and (2) in the air immediately before landing or after taking off and while the airplane is at or near its minimum flying speed.
2. *Class B—Collisions in full flight with objects other than aircraft.*—This includes collisions while at flying speed and with power plant functioning normally with trees, poles, houses, mountain sides, or other obstacles. It includes collisions with the earth or water by diving. It excludes collisions (1) on the ground while taxiing, taking off, or landing, and (2) in the air immediately before landing or after taking off and while the airplane is at or near its minimum flying speed.
3. *Class C—Tail spins following engine failure.*—This includes spins, stalls, and all collisions with the earth while the airplane is out of control due to loss of flying speed following engine failure.
4. *Class D—Tail spins without engine failure.*—This includes spins, stalls, and all collisions with the earth while the airplane is out of control following loss of flying speed, with the engine functioning normally. It includes spins due to structural failure or defective handling qualities of the airplane.
5. *Class E—Forced landings.*—This covers accidents while making landings necessitated by conditions which could not be overcome while in flight. Such conditions include engine trouble and other defects of the aircraft, loss of knowledge of the direction to the destination or the location on the map of the aircraft's position, bad weather, darkness, and exhaustion of fuel.
6. *Class F—Landing accidents.*—This includes accidents while the pilot is in the act of executing a voluntary landing. It does not include forced landings or accidents while examining a field from the air or approaching it for a landing.
7. *Class G—Take-off accidents.*—This includes accidents occurring between the time of starting a take-off to the time when full flying speed is gained, except those covered under other classifications, as, for instance, tail spins or forced landings.

8. *Class H—Taxying accidents.*—This includes all accidents which occur while the aircraft is maneuvering under its own power on land or water. It excludes accidents while the aircraft is still moving after a landing or while it is getting up speed for a take-off.
9. *Class I—Fires in the air.*—This includes all accidents in which fire breaks out, either as a cause or result of the occurrence, while the aircraft is in flight.
10. *Class J—Carrier, platform, and arresting-gear accidents.*—This includes accidents occurring while the aircraft is landing upon or taking off from (1) the deck of a floating aircraft carrier, or (2) an elevated platform intended for the landing and taking off of aircraft, but excludes launching-gear accidents.
11. *Class K—Launching gear accidents.*—This includes accidents during take-off in which the aircraft is assisted in gaining flying speed by the application of an external force.
12. *Class L—Miscellaneous.*—This includes accidents the nature of which is known but which do not fall into one of the above classifications.
13. *Class M—Indeterminate and doubtful.*—This includes all accidents concerning the nature of which so little is known that any classification can not be intelligently accomplished.

## II. INJURY TO PERSONNEL

This consists of dividing accidents into separate classes according to the injury suffered by personnel in such aircraft.

1. *Class A.*—A "Class A" injury is one resulting in the death of the individual within a period of 90 days.
2. *Class B.*—A "Class B" injury is one resulting in serious injury to the individual. Because of the difficulties of classification, the opinion of a physician should be obtained whenever possible as to whether an injury is severe or minor. When a physician is not available, the following general rules should be followed: Any injury that results in unconsciousness; any fracture of any bone except simple fractures of the fingers and toes; lacerations that involve muscles or cause severe hemorrhage; any injury to any internal organ; or any other injury that it seems probable will incapacitate the individual for more than five days should be classed as a severe injury. All other injuries should be classed as minor.
3. *Class C.*—A "Class C" injury is one resulting in only minor injury to the individual.
4. *Class D.*—Any personnel who experience an aviation accident with no personal injury shall be classified as "Class D."

NOTE.—The classification of an accident according to injury to personnel shall contain a letter for each individual in the aircraft at the time of the accident, the first of these letters representing the pilot of the aircraft. For example, in an accident where the pilot is killed, one passenger seriously injured, and the remaining passenger escapes with only minor injury the accident would be classified as a Class ABC accident. Had the pilot escaped with minor injury and both passengers been killed, it would have been a Class CAA accident.

## III. DAMAGE TO MATÉRIEL

This consists of dividing accidents into separate classes according to the amount of damage which occurs to matériel.

1. *Class A.*—This includes all accidents as a result of which the aircraft is of no further value except for salvage of usable parts.
2. *Class B.*—This includes all accidents as a result of which it is necessary to completely overhaul the aircraft before it would be again airworthy.
3. *Class C.*—This includes all accidents as a result of which it is necessary to replace some major assembly of the aircraft before it would be again airworthy, such as a wing, fuselage, undercarriage, tail, or engine. Accidents in which the damage to the engine or other major assembly was a *cause* and not a *result* are excluded from this category unless the remaining damage warrants such.

4. *Class D.*—This includes all incidents which because of other factors come within the category of an aircraft accident and as a result of which there is only minor and easily repairable damage to the aircraft, such as a broken tail skid, wheel, bent propeller tip, etc.
5. *Class E.*—This includes all incidents similar to Class D accidents above in which there is no damage to matériel.
6. *Class F.*—"Class F" is included in this analysis only because of the interest it may have for the different organizations which may use this method of analyzing. It consists of matériel failures which did not result in an accident, and, strictly speaking, does not actually fit into an accident analysis. However, the methods here used for analyzing matériel failures which did result in accidents can as easily be applied to those which did not, and thus afford a method of studying the potential accidents, which because of other reasons did not occur, such as a successful landing after engine failure, etc.

#### CAUSES OF ACCIDENTS

The following classifications for study of aircraft accidents according to their causes are recommended:

##### A. IMMEDIATE CAUSES OF AIRCRAFT ACCIDENTS

The following is a proposed list of immediate standard causes of aircraft accidents, with definitions where considered necessary for clarity.

- I. *Personnel.*—This includes all accidents which can be traced to persons accessory to the operation of the aircraft, either on the ground or in the air. This does not include accidents due to errors or omissions of personnel charged with the design, manufacture, maintenance, or inspection of aircraft.
  1. *ERRORS OF PILOT.*—This includes all accidents the responsibility for which rests upon the pilot. The pilot is the actual manipulator of the controls or the individual responsible for their correct manipulation.
    - (a) *ERROR OF JUDGMENT.*—This includes all accidents resulting from a decision made by the pilot which was not the best possible under existing circumstances.
    - (b) *POOR TECHNIQUE.*—This includes all accidents resulting from lack of skill, dexterity, or coordination of the senses in handling aircraft controls, whether traceable to inherent inability to attain such or to infrequent flying, lack of experience in flying, lack of experience in flying under particular conditions, or in the particular type of aircraft.
    - (c) *DISOBEDIENCE OF ORDERS.*—This includes all accidents resulting from the violation or disobedience of local or general orders or regulations or provisions of law governing the operation of aircraft, such as low acrobatics, acrobatics in aircraft not to be used for such purposes, or any other type or manner of operation specifically forbidden by orders or regulations issued by competent authorities.
    - (d) *CARELESSNESS OR NEGLIGENCE.*—This includes all accidents resulting from the absence of care on the part of the pilot according to circumstances or the failure to use that degree of care which the circumstances justly demand, either on the ground or in the air, such as careless manipulation of the controls of an aircraft, failure to ascertain the amount of gasoline on board before taking off, failure to ascertain the conditions of the instruments, etc.
    - (e) *MISCELLANEOUS.*—This includes all accidents resulting from errors of the pilot not accounted for above.

I. *Personnel*.—Continued.

2. **ERRORS OF SUPERVISORY PERSONNEL.**—This includes all accidents the responsibility for which rests upon individuals other than the pilot who exercise control over the operation of the aircraft, such as navigators, formation section leaders, ground-operations officers, etc.
3. **ERRORS OF OTHER PERSONNEL.**—This includes all accidents the responsibility for which rests upon other personnel directly concerned with the operation of the aircraft, such as members of the flight and ground crews of the aircraft, aerographers, etc.

II. *Matériel*.—This includes all accidents resulting from failures of the airplane, power plant, accessories, and launching and arresting devices, whether traceable to materials, faulty design, maintenance, or inspection.

1. **POWER-PLANT FAILURE.**—This includes all accidents resulting from failure or malfunctioning of the propelling system and all auxiliaries essential to its proper functioning, exclusive of instruments.
  - (a) FUEL SYSTEM.
  - (b) COOLING SYSTEM.
  - (c) IGNITION SYSTEM.
  - (d) LUBRICATION SYSTEM.
  - (e) ENGINE STRUCTURE.
  - (f) PROPELLER AND PROPELLER ACCESSORIES.
  - (g) ENGINE CONTROL SYSTEM (THROTTLE ROD, ETC.).
  - (h) MISCELLANEOUS.
  - (i) UNDETERMINED.
2. **STRUCTURAL FAILURE.**—This includes all accidents resulting from failures of the airplane exclusive of the propelling system and instruments.
  - (a) FLIGHT CONTROL SYSTEM.
  - (b) MOVABLE SURFACES.
  - (c) STABILIZING SURFACES.
  - (d) WINGS, STRUTS, AND BRACING.
  - (e) **LANDING GEAR.**—This includes all accidents resulting from failure of the landing-gear struts and shock-absorbing gear, but does not include accidents resulting from failure of the wheels or floats attached thereto.
    - (f) WHEELS, TIRES, AND BRAKES.
    - (g) SEAPLANE FLOAT OR BOAT.
    - (h) FUSELAGE, ENGINE MOUNT, AND FITTINGS.
    - (i) TAIL SKID OR WHEEL ASSEMBLY.
    - (j) ARRESTING APPLIANCES ON AIRCRAFT.
    - (k) MISCELLANEOUS.
    - (l) UNDETERMINED.
3. **HANDLING QUALITIES.**—This includes all accidents resulting from those peculiar characteristics of certain types of aircraft affecting their controllability while on the ground or in the air, such as marked tendency to ground loop, inability to recover from a spin, etc.
4. **INSTRUMENTS.**—This includes all accidents resulting from failures of instruments which were essential to operation under the conditions of the flight.
5. **LAUNCHING DEVICES.**—This includes all accidents resulting from failure or malfunctioning of catapults.
6. **ARRESTING DEVICES.**—This includes all accidents resulting from failure or malfunctioning of arresting gear not a part of the aircraft.

III. *Miscellaneous*.—This includes all accidents not accounted for above but those causes are determined.

1. WEATHER.—This includes all accidents resulting from conditions of the weather which could not reasonably have been foreseen and avoided. (Mention may be made on the chart of contributing weather causes, as fog, gale, ice, hail, snow, rain, lightning, etc.)
2. DARKNESS.—This includes all accidents resulting from conditions due to nightfall which could not reasonably have been foreseen and avoided.
3. AIRPORT OR TERRAIN.—This includes all accidents resulting from airports or landing conditions of places which could not reasonably have been detected or avoided. (Forced landings should be charged to power plant, etc., unless report shows that safe landing could have been made, in which case the crash would probably be attributed to error of judgment or poor technique.)
4. OTHER.—This includes all accidents resulting from causes not otherwise accounted for above.

IV. *Undetermined and doubtful*.—This includes all accidents the causes of which are either undetermined or doubtful.

#### B. UNDERLYING CAUSES OF AIRCRAFT ACCIDENTS

The following is a list of standard underlying causes of aircraft accidents, with definitions where considered necessary for clarity.

I. *Errors of pilot*.—Returning to "Errors of pilot," paragraph I, subparagraph 1, above, the subdivisions of this paragraph were made according to the immediate causes of the errors attributed to the pilot, such as an "Error of judgment," "Poor technique," etc. The underlying causes of such errors may frequently be of more interest than the actual causes themselves. These causes may be defined as those elements which contributed to the pilot's mental and physical equipment at the time of the accident or to the deficiencies which existed in such equipment.

1. LACK OF EXPERIENCE.—This includes all accidents resulting from insufficient personal acquaintance with the actual conditions which had to be met under the circumstances.

(a) LACK OF GENERAL EXPERIENCE.—This includes all accidents resulting from a lack of experience in the general problems of aviation, such as landing, taking off, air work, etc.

(1) LACK OF TOTAL GENERAL EXPERIENCE.—This includes all accidents resulting from a lack of general experience due to the fact that the individual concerned has never engaged in such work for a sufficient period of time to acquire the necessary experience to have avoided such accidents.

(2) LACK OF RECENT GENERAL EXPERIENCE.—This includes all accidents resulting from a lack of general ability due to the fact that the individual concerned has too infrequently engaged in general flying activities prior to the accident, and consequently lost the ability he had originally acquired.

(b) LACK OF SPECIAL EXPERIENCE.—This includes all accidents resulting from a lack of experience in special problems of aviation, such as certain features of cross-country flying (which might, for example, require an intimate knowledge of the terrain of a certain section), carrier operations, night flying, blind flying, etc.

(1) LACK OF TOTAL SPECIAL EXPERIENCE.—This includes all accidents resulting from a lack of special experience due to the fact that the individual had never engaged in such special problems for a sufficient period of time to acquire the necessary experience to have avoided such accidents.

I. *Errors of pilot*—Continued.

## 1. LACK OF EXPERIENCE—Continued.

## (b) LACK OF SPECIAL EXPERIENCE—Continued.

(2) LACK OF RECENT SPECIAL EXPERIENCE.—This includes all accidents resulting from a lack of ability in the special problems due to the fact that the individual concerned has too infrequently engaged in special flying activities prior to the accident, and consequently lost the ability he had originally acquired.

## 2. PHYSICAL AND PSYCHOLOGICAL CAUSES.—This includes all accidents resulting from a demonstrable disease or defect or poor reaction.

(a) DISEASE OR DEFECT.—This includes all accidents resulting from a disease or defect, demonstrable by physical (including nervous system) examination.

(1) INHERENT DISEASE OR DEFECT.—This includes all accidents resulting from a disease or defect which is not susceptible to remedy within a reasonable period of time, such as overshooting a field, faulty landings or collision because of defective vision or judgment of distance; unconsciousness; hysterical or epileptic tendency; chronic air sickness; inability to withstand altitude, etc. The history of an individual may often be necessary to determine if a disease or defect is inherent.

(2) TEMPORARY DISEASE OR DEFECT.—This includes all accidents resulting from a disease or defect which is remediable and one which may not be expected to repeat itself with undue frequency in the individual concerned, such as fatigue, either mental or muscular, staleness, temporary illness, incomplete convalescence, etc.

(b) POOR REACTION.—This includes all accidents which result from no demonstrable disease or defect but from psychological causes, making the individual react either erroneously or slowly to a situation, such as selecting what is manifestly the poorer of two fields for an emergency landing, persisting on a course when better judgment would indicate that he should land or turn back, indulging in acrobatics over prohibited areas or at too low altitude, etc.

(1) POOR REACTION, INHERENT.—This includes all accidents resulting from psychological causes which apparently are not susceptible to correction within a reasonable period of time. The history of the individual would be a very important adjunct in determining if such poor reaction were inherent and its repetition to be frequently expected.

(2) POOR REACTION, TEMPORARY.—This includes all accidents resulting from psychological causes which apparently are subject to correction, disciplinary or otherwise, within a reasonable period of time.

II. *Matériel failures*.—The underlying causes of “*matériel failures*” should also prove of considerable interest in analyzing accidents.

1. FAULTY INSTRUCTIONS.—This includes all accidents resulting from *matériel failures* which were traceable to errors or omissions in the standard instructions covering the use of such *matériel*.

(a) FAULTY OPERATING INSTRUCTIONS.—This includes all accidents resulting from *matériel failures* which were traceable to the operation of such *matériel* in accordance with standard instructions which prove to be incorrect or incomplete, such as instructions governing the use of the mixture control which when carried out are found to damage the engine, instructions governing the proper engine operating temperature which when carried out are found to damage the engine, etc.

(b) FAULTY MAINTENANCE INSTRUCTIONS.—This includes all accidents resulting from *matériel failures* which were traceable to the maintenance of such *matériel* in accordance with standard instructions which prove to be incorrect or incomplete, such as instructions governing the type of protective coating to cover duralumin parts when operating as a seaplane, etc.

2. FAULTY INSPECTION.—This includes all accidents resulting from *matériel failures* which were traceable to errors or omissions in the inspection of such *matériel*.

(a) FAULTY MANUFACTURING INSPECTION.—This includes all accidents traceable to faulty inspection of *matériel* where such errors or omissions occurred prior to the receipt of this *matériel* by the consumer.

(b) FAULTY OVERHAUL INSPECTION.—This includes all accidents traceable to faulty inspection of *matériel* where such errors or omissions occurred during overhaul or storage of the *matériel*.

(c) FAULTY MAINTENANCE INSPECTION.—This includes all accidents traceable to faulty inspection of *matériel* where such errors or omissions in inspection occurred after the final delivery of this *matériel* to the operating unit.

(d) FAULTY INSPECTION, INDETERMINATE.—This includes all accidents traceable to faulty inspection of *matériel* where actual responsibility for the errors or omissions in inspection can not be definitely placed.

3. FAULTY MATERIALS.—This includes all accidents resulting from *matériel failures* which were traceable to defective materials when such defects in materials could not reasonably have been detected and eliminated by a proper system of inspection.

(a) ORIGINALLY DEFECTIVE MATERIALS.—This includes all accidents traceable to faulty materials where the materials contained such defects when originally delivered.

(b) DETERIORATED MATERIALS.—This includes all accidents traceable to faulty materials where the defects of such materials occurred through deterioration after delivery.

(c) FAULTY MATERIALS, INDETERMINATE.—This includes all accidents traceable to faulty materials where it is not possible to determine the actual time or place when such defects first appeared.

## II. *Material failures.*—Continued.

4. **FAULTY DESIGN.**—This includes all accidents resulting from matériel failures which were traceable to errors or omissions in the original design of such matériel.

(a) **FAULTY DESIGN, ORIGINAL.**—This includes all accidents traceable to faulty design where such errors or omissions in design occurred in the original design of such matériel, or in the course of changes initiated or directed by persons having recognized authority regarding design or construction.

(1) **FAULTY ORIGINAL DESIGN, STRUCTURAL STRENGTH.**

(2) **FAULTY ORIGINAL DESIGN, ARRANGEMENT.**

(3) **FAULTY ORIGINAL DESIGN, AERODYNAMIC.**

(4) **FAULTY ORIGINAL DESIGN, INDETERMINATE.**

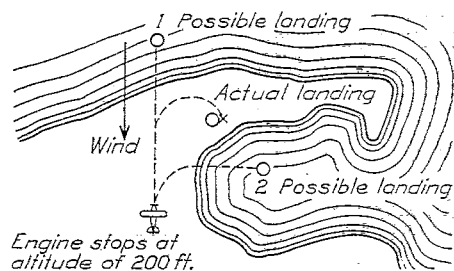
(b) **FAULTY DESIGN, MODIFICATION.**—This includes all accidents traceable to faulty design where such errors or omissions in design occurred in modifications to the original design of such matériel initiated or directed by persons not having recognized authority regarding design or construction (such as jury rigs, emergency repairs, etc.).

5. **INDETERMINATE MATÉRIEL FAILURE.**—This includes all accidents from matériel failures the exact source of which can not be determined.

### DESCRIPTION AND TYPICAL ANALYSIS OF AN ACCIDENT

Pilot John Doe was flying in a seaplane at 200 feet altitude over a point of land between a bay and the open sea when the engine stopped. Pilot Doe had an opportunity to land either directly into the wind in the open sea or cross wind in the bay. He started to land in the ocean, but at 100 feet altitude he changed his mind and attempted to turn so as to land in the bay.

In turning, Doe held the nose of the seaplane up, stalled it, and spun into the land. The seaplane was demolished, the pilot was seriously injured, and the passenger was killed.



Doe, according to his record, was an experienced aviator with 30 hours' flying during the preceding month and with recent experience in stunting seaplanes.

Examination of the engine showed that one of the teeth in the magneto timing gear had stripped, the broken tooth having been drawn into the other teeth, causing the eventual stripping of all teeth. The original break was determined to be a visible hardening crack.

The NATURE of this accident is Class C—Tail spin following engine failure, as defined on page 9. The classification according to RESULTS is Personnel, Class BA (p. 10); Matériel, Class A.

In analyzing this accident the IMMEDIATE CAUSE is charged, as indicated on the analysis chart, as 75 per cent "Personnel" and 25 per cent "Matériel," for the reason that the account of the accident shows that the pilot had two chances to make a safe landing and took advantage of neither of them. Considering the 75 per cent which is charged to "Personnel," it is obvious that this is chargeable neither to "Errors of supervisory personnel" nor to "Errors of other personnel," so that the whole weight, 75 per cent, must be placed under "Errors of pilot." It appears further that the errors of the pilot involved errors of judgment in that he lost altitude while wavering indecisively between landing in the ocean and attempting to land in the bay. It appears that poor technique was the most important single factor in that he continued to pull the nose up, still further stalling the seaplane, when he should have sensed the approaching stall. It is considered that a charge of 35 per cent to "Error of judgment" and 40 per cent to "Poor technique" represents as near an approximation as can be arrived at in this case.



Approved by Executive Committee N. A. C. A., October 3, 1928

On analysis of UNDERLYING CAUSES it would appear that the "Error of judgment" and "Poor technique" were both due to a "Temporary poor reaction" with a strong possibility of such "Poor reaction" being "Inherent" rather than "Temporary." However, in the absence of a history of the individual this would have to be classified as "Temporary."

Considering the 25 per cent charged to "II. Matériel," the entire 25 per cent obviously should be assigned to "1. Power-plant failure," in the second order of subdivision, and again in the third order of subdivision the entire 25 per cent should be charged to "(c) Ignition system."

The underlying cause of this matériel failure is unquestionably faulty manufacturing and accordingly on the cross analysis it would be placed under the head of "Manufacturing inspection."

#### CONCLUSION AND RECOMMENDATIONS

The special committee on the nomenclature, subdivision, and classification of aircraft accidents, having studied in considerable detail the problem of classifying and analyzing the causes of aircraft accidents, at its final meeting held on July 17, 1928, unanimously adopted a resolution approving this report and recommending that it be published by the National Advisory Committee for Aeronautics and that copies be transmitted to the War, Navy, and Commerce Departments with a recommendation that the proposed method of analysis of aircraft accidents outlined in the report be adopted for use in their respective services. The special committee recommends further that copies of the report be transmitted also to the appropriate representatives of the various interested foreign governments with a request that they cooperate by contributing information from time to time in relation to aircraft accidents.

With the submission of this report the work of the special committee is concluded and it should be discharged. It is probable, however, that the introduction of the proposed chart for the analysis of accidents will result in questions as to interpretation and suggestions for changes, many of which, it is believed, have been considered during the meetings of the committee. It is also probable that study of the information obtained from the application of the method of analysis will indicate that certain features in aircraft construction or operation should be given more detailed study or consideration. The committee therefore at its final meeting adopted a resolution recommending that its present personnel be reorganized into a standing committee on aircraft accidents of the National Advisory Committee for Aeronautics for the purpose of considering from time to time such new matter regarding aircraft accidents as may appear desirable or as may be brought before it.

Respectfully submitted.

SPECIAL COMMITTEE ON THE NOMENCLATURE, SUBDIVISION,  
AND CLASSIFICATION OF AIRCRAFT ACCIDENTS.

GEORGE K. BURGESS, *Chairman*.

WASHINGTON, D. C., August 15, 1928.

